Can Smart Farming Reduce the Vulnerability to Climate Change and Disasters?

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김해시

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Structure of presentation

- Perception of Smart Farming (1)
- Major challenges of climate change and increased disasters (2)
- Major challenges to food security (3)

Part 1: Perception of Smart Farming

- Smart Farming
  - Is a highly sophisticated way to produce food and agricultural products
  - Employs high tech
    - Agricultural machinery
    - Buildings targeted to optimize agricultural production
  - Internet of Things in Agriculture
    - Connected sensors
      - Measuring ever more detailed production processes
    - Generating more data -> BIG DATA

Robotractors in Japan

Link: https://govinsider.asia/smart-gov/four-things-you-should-know-about-smart-farming/

Battery-powered robot tractors in USA: John Deere SESAM tractor

http://www.edp24.co.uk/business/farming/battery-powered-robot-tractors-science-fiction-or-the-farm-technology-of-the-next-decade-1-5007473

Drones used in European Agriculture

http://www.europarl.europa.eu/resources/library/images/20160616PHT32412/20160616PHT32412-cl.jpg

Automated Grape Harvester in France

Source: http://wall-ye.com/

Field Sensors

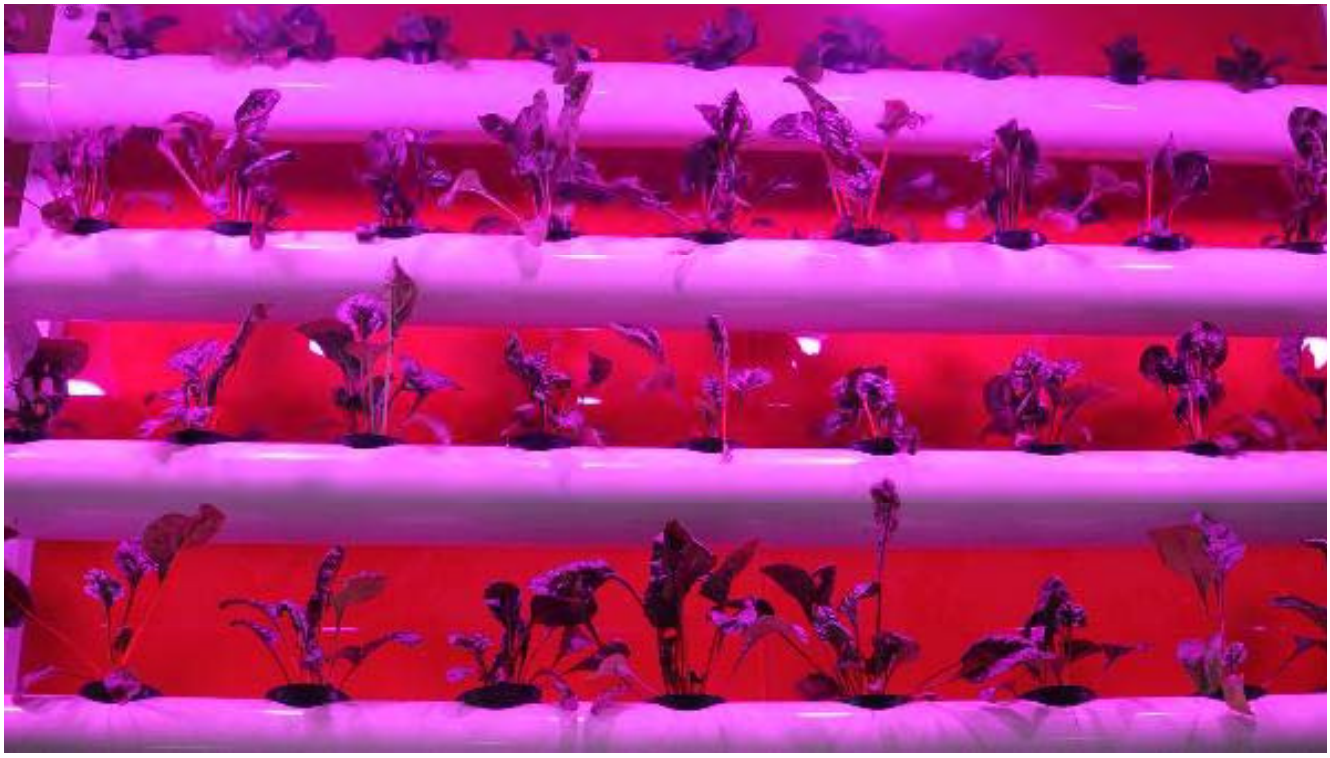
- Versatile field phenotyping - Example PheNode Sensor
  - Temperature
  - Precipitation
  - Light quantity
  - Light quality
  - Humidity
  - CO2
  - Wind speed
  - Air quality
  - Soil moisture
  - Soil temperature
  - pH
  - Nutrient composition

Source: Donald Danforth Plant Science Center , https://www.danforthcenter.org/

Smart Farming Paprika Glasshouse

Aquaponic Fish & Plant Production in Korea

Aquaponic System

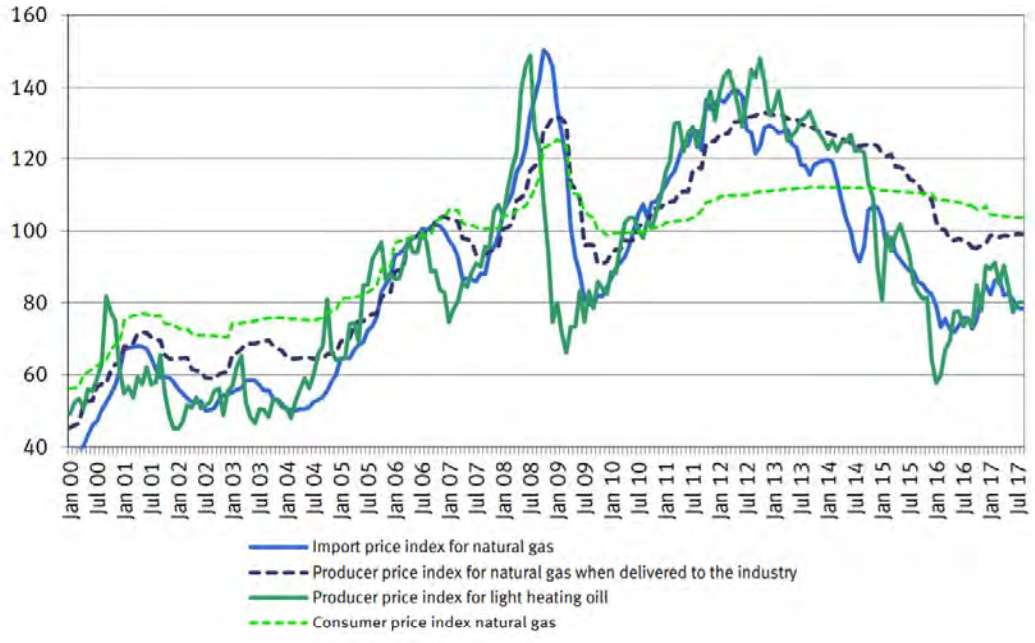


Lettuce Smart Farming in Plant Factory

Plant Factory Growth Chamber Control Center

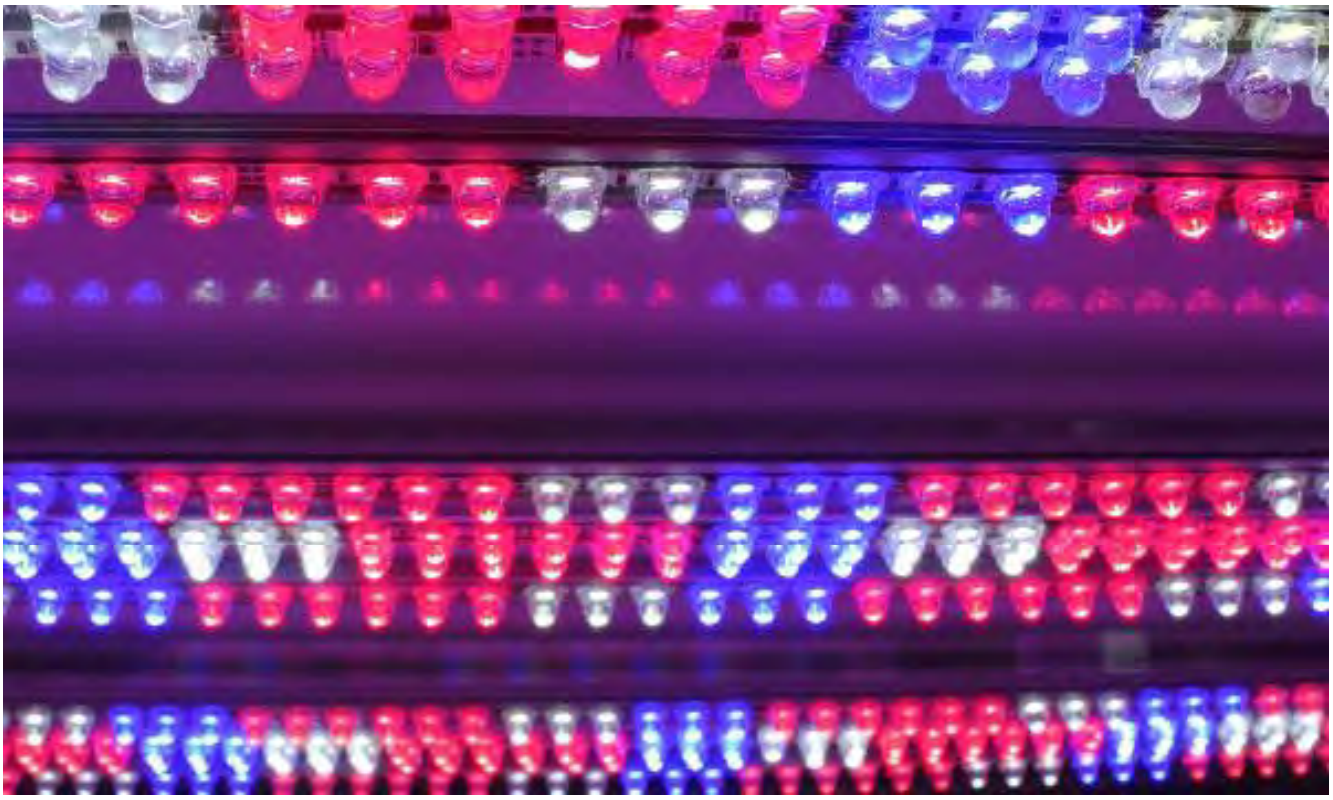
- Full control via sensors and adjustment of
  - Light
  - Temperature
  - Humidity
  - Water
  - Nutrient intake
- Resource demands
  - Artificial built environment
  - Different and sophisticated technologies
  - Energy

Energy price fluctuations 2000 – 2017

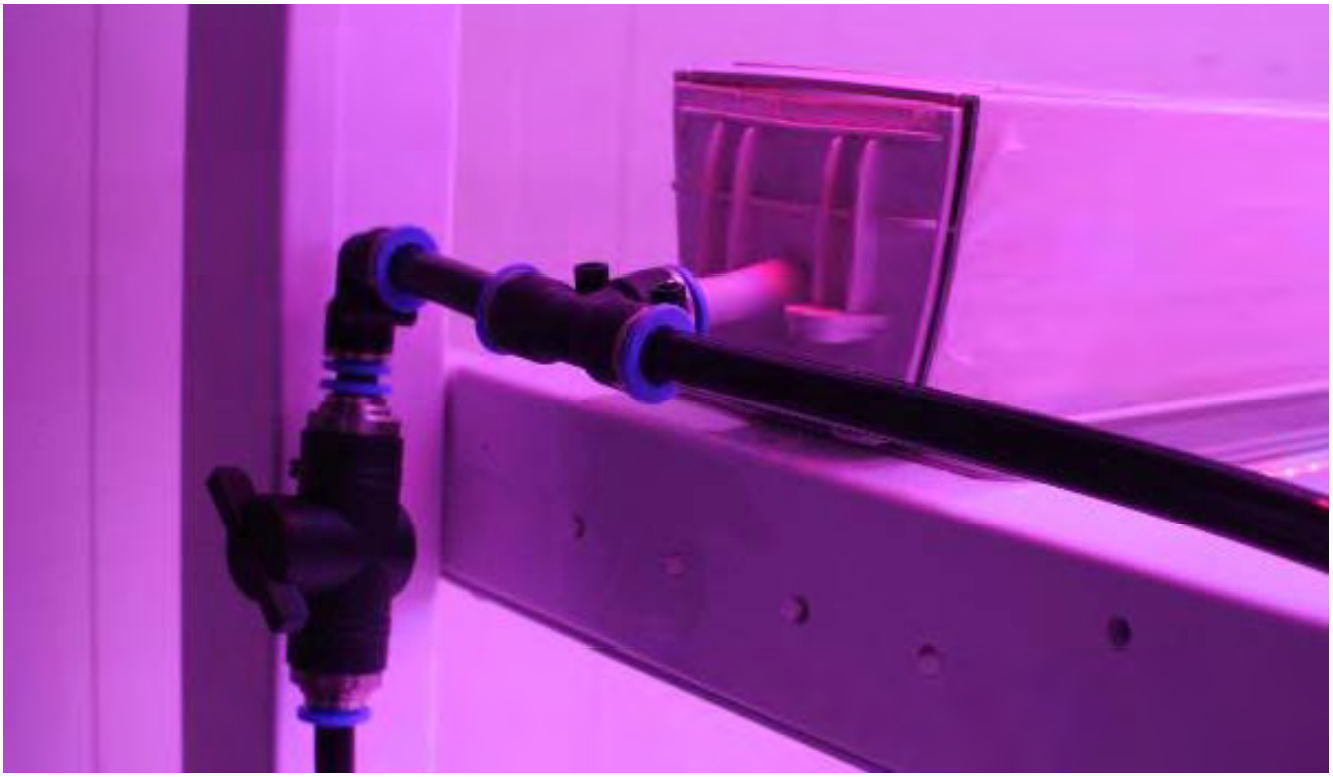


Source: D_Statis 2017 Data on energy price trends

Plant Factory Light Regulation



Plant Factory
Water and Nutrient Regulation



Smart Farming Melon Glasshouse

- Stable and optimized climate conditions
- Optimal ratio fruit growth to leave growth
- Adjusted and optimized for one particular fruit
- Environmental inputs can be widely optimized
  - Substrate
  - Nutrient flow
  - Energy
  - Fertilizer
  - Pesticides

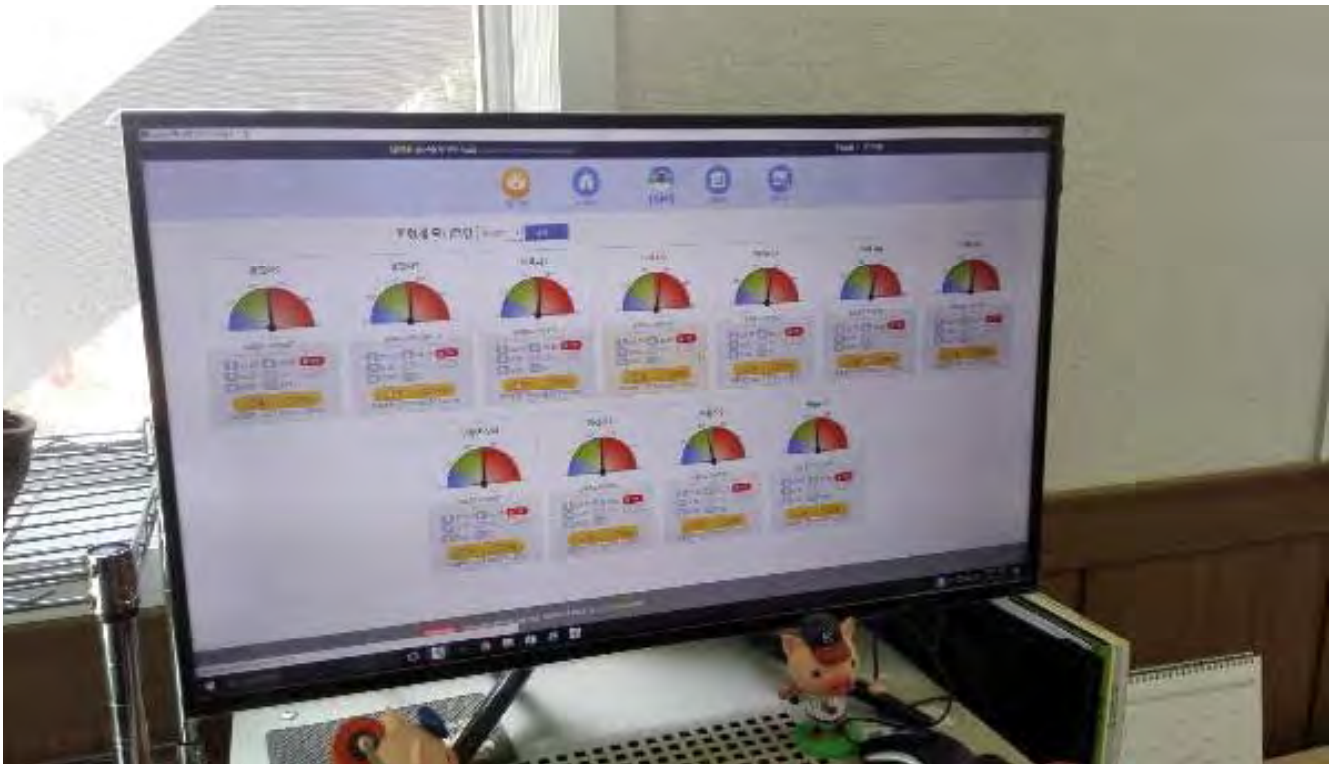
Alternative ways to counter pests: natural enemies

Resource Optimization through Smart Farming

- Recycling of materials becomes easier by controlled water and nutrient flows
  - Targeted inputs of nutrients and water becomes possible
- CO2 can be mitigated in glasshouses
  - Plants demand relatively high concentrations of CO2 around 700 ppm for optimal growth
- Animal manure from waste to product
  - can be collected in standardized ways and become a source of energy or natural fertilizer
- Transportation can be avoided
  - Many products currently imported from far away can become „local products“.
  - Products that are difficult to transport can enrich local diets

Livestock Swine Smart Farming

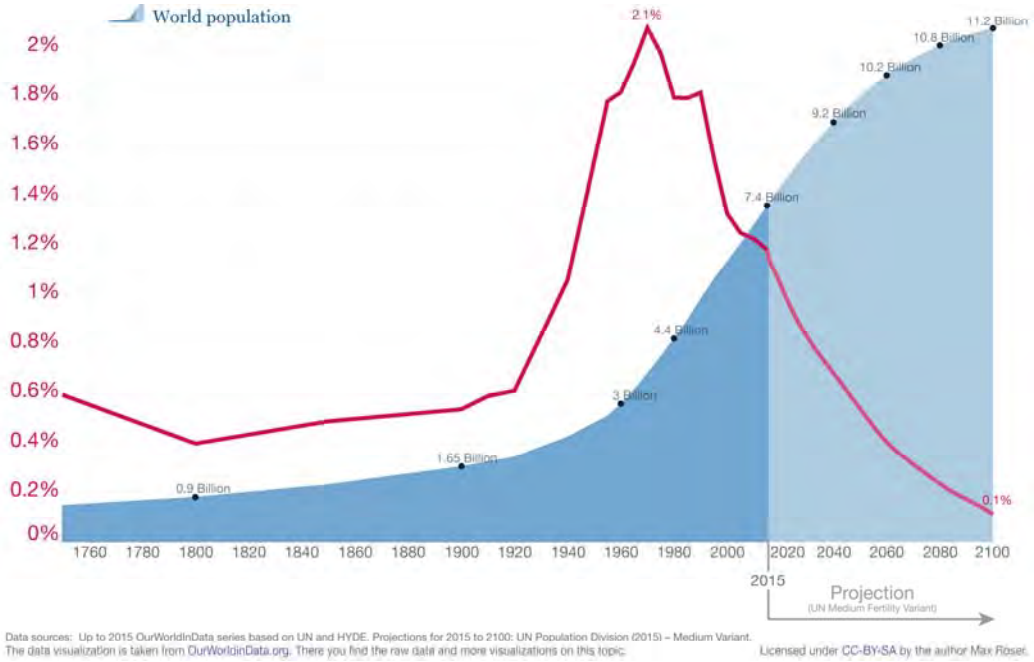
Control Unit to Lifestock Smart Farming



Part 2: Major challenges of climate change and increased disasters

- Growth
  - Population growth, economic growth,
  - Resources decline, pollution increase,
- Climate change
  - Emission increase, land use change as drivers
  - Concentration of CO2 in atmosphere
    - Stabilizing at 450 ppm required
    - Allowing global warming at maximum with 2°C
- Disasters
  - Will be more frequent in the future
  - Damage may grow from current 0.1% of global GDP to several percent
  - Poorest people are likely to suffer most

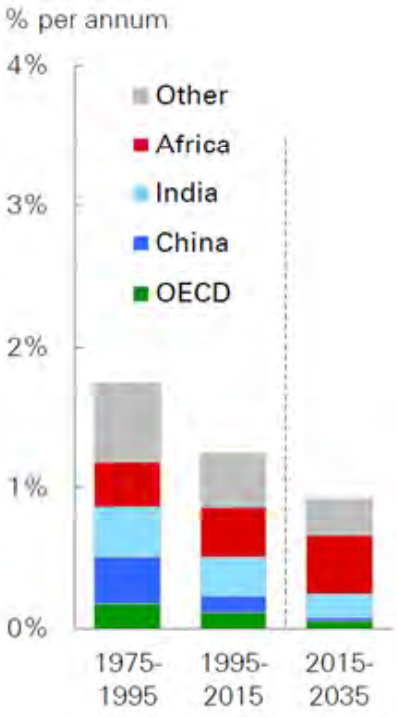
Growth of World Population 1750 to 2100



Source, https://ourworldindata.org/world-population-growth/

Population Growth by World Region

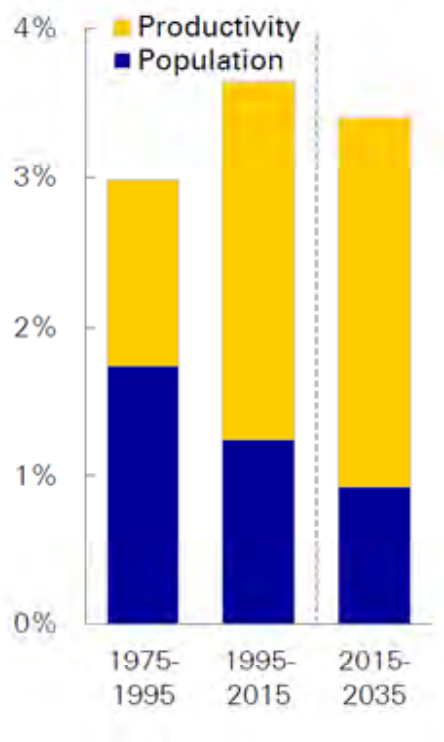
- Population Increase
  - From 3 billion in 1960
  - to 7.6 billion today
  - to 11.2 billion in 2100
    - Highest population growth in Africa
- Growth Declined
  - From 2.1% in 1975 to currently 1%



Source: BP Energy Outlook – 2017 edition

Real GDP Growth Productivity Driven

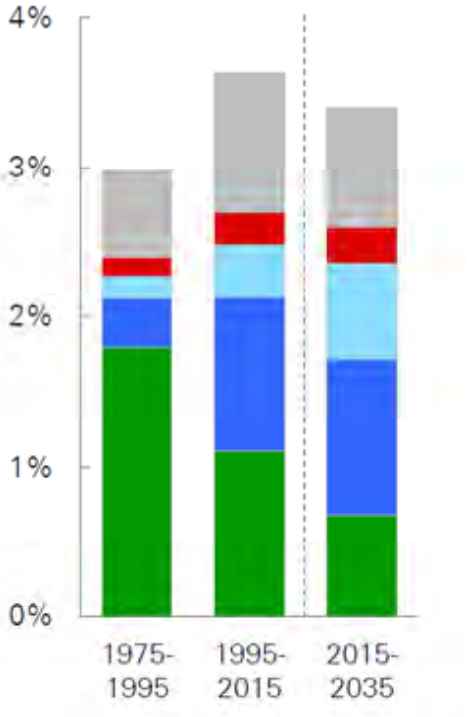
- World GDP was constantly growing with annually 3.5 percent
- Decoupling of growth from population
  - Population is no longer the growth stimulous
  - Particular true for mature economies



Source: BP Energy Outlook – 2017 edition

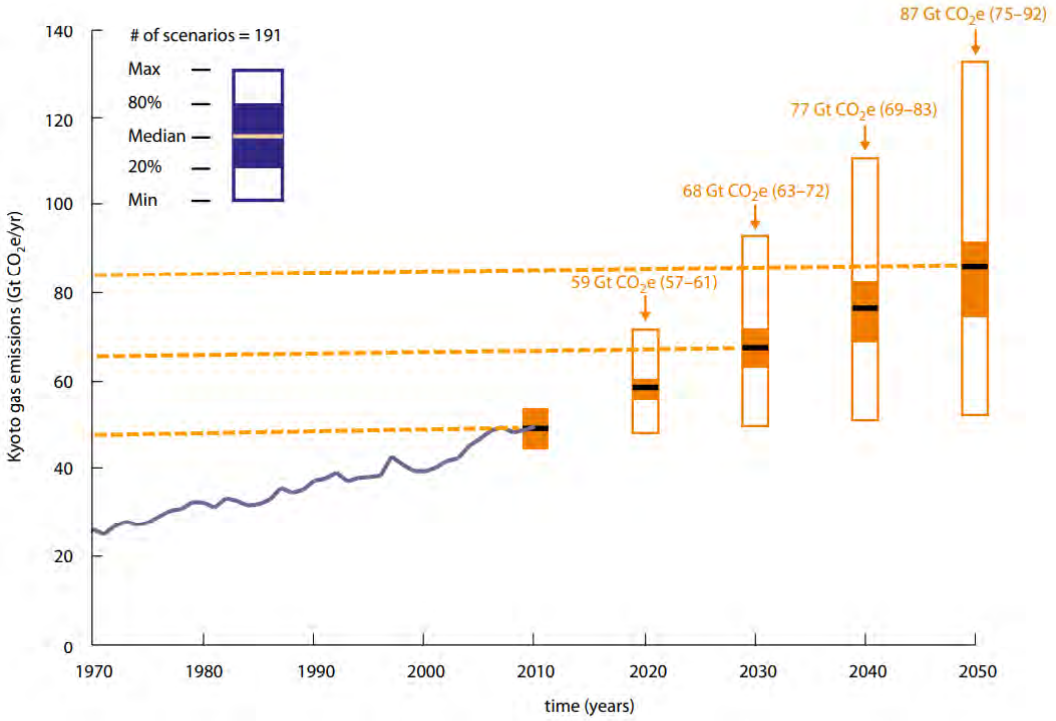
Real GDP by Region

- Global GDP
  - During 1975 and 1995 first OECD countries increasing importance
  - During 1995 and 2015 second China´s growth and increased importance
  - During next period until 2035 growth in India, African region and other countries



Source: BP Energy Outlook – 2017 edition

Global Emissions of Greenhouse Gases – Business like Usual



Source: UNEP 2014, The Emission Gap Report, p. 35, modified

Mitigation Efforts: From Kyoto to Paris

- In 1997 there was COP3 and agreement on the Kyoto Protocol
  - Stabilize greenhouse gases at 1990 levels until 2012
- In 2009 there was COP15 and insight in Copenhagen that stabilization is impossible
  - Instead a maximum of 2°C warming target was established
- In 2015 there was COP21 and Paris Accord
  - Considered as a milestone
  - But trackback from USA in 2017

Global 500 Businesses Greenhouse Gas Emissions

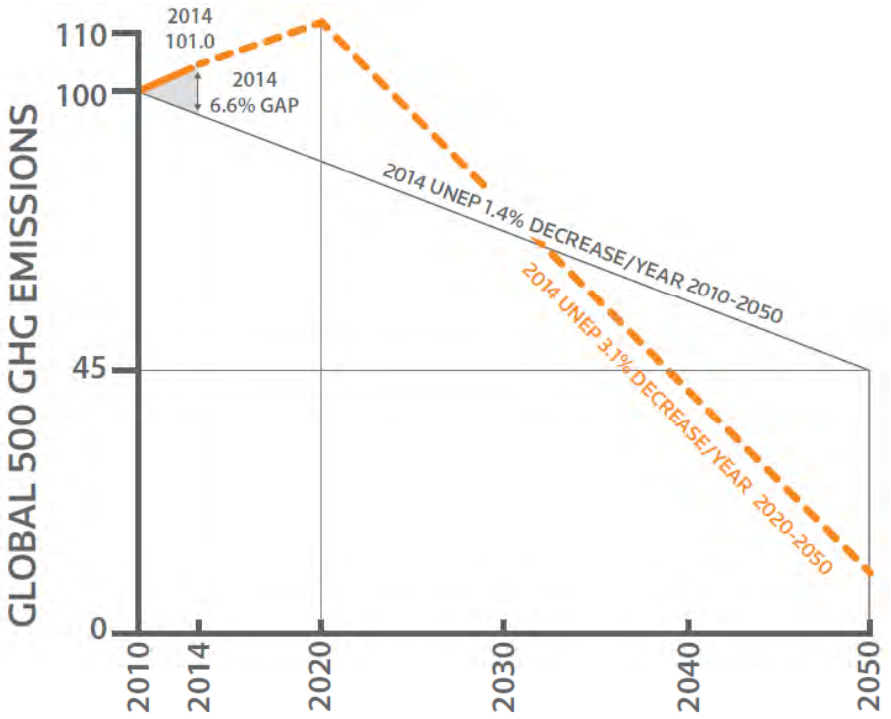
- The world's 500 largest businesses collectively emitted over 5 gigatons
  - 10% of global emissions of CO^2e through operations and purchase of energy
  - represent around 28% of global GDP
    - reflect more broadly on how the broader economy is responding to the climate challenge
  - 1% increase during 2010 and beginning of 2015

Source: Thompson and Reuters (2016) REPORT ON TRENDS- GLOBAL 500 GREENHOUSE GASES PERFORMANCE 2010-2015

2013 UNEP: 1.4% annual emission decline needed

Or:

3.1 % annual decline during 2020 and 2050

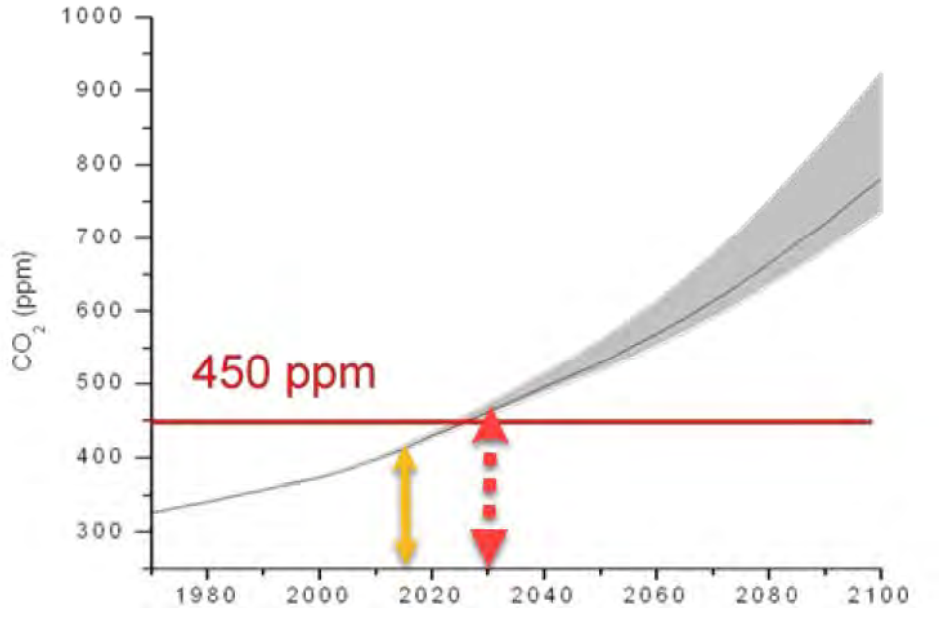


Source: Thompson and Reuters (2016) REPORT ON TRENDS- GLOBAL 500 GREENHOUSE GASES PERFORMANCE 2010-2015

Speed of warming and change accelerates!

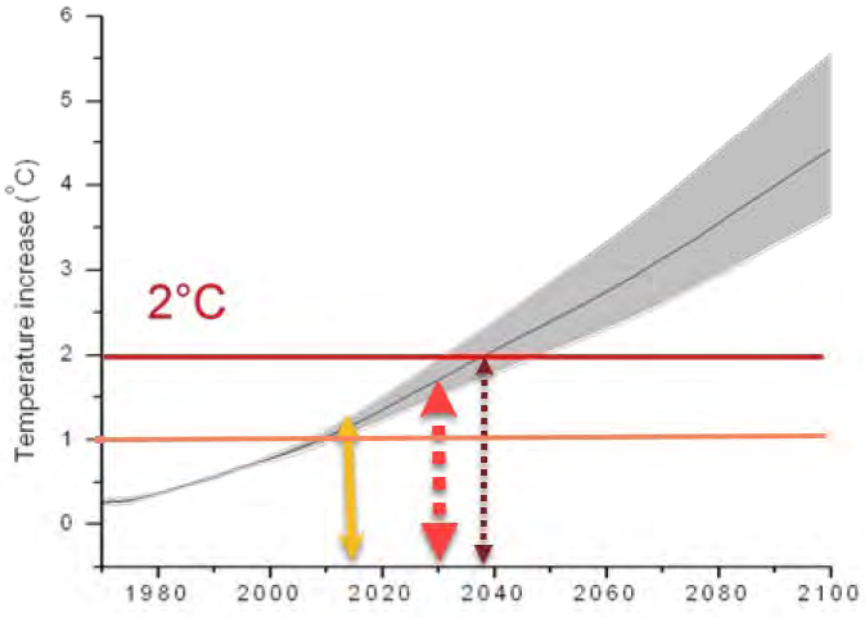
- Despite all efforts to mitigate climate change the problem increases
- The speed of warming and change accelerates
- Comparison to a car on the highway if we currently drive 100km/h :
  - During 1970 and 1990 we accelerated to 60km/h
  - During 1990 and 2010 we accelerated to 90km/h
  - During 2010 and 2030 we drive 130 km/h
  - During 2030 and 2050 we will drive 180 km/h

Can we stabilize the CO2 concentration in the atmosphere?



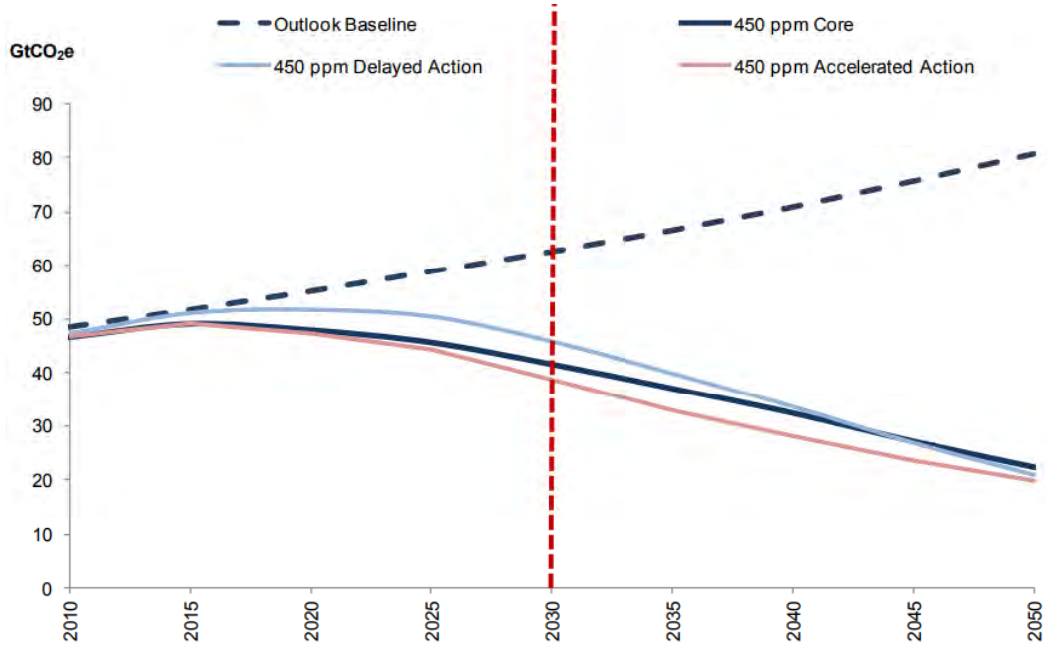
Source: The OECD Environmental Outlook Baseline Projections, Image Model, 2012, modified

Maximum of 450 ppm CO2 considered to stabilize warming at 2°C



Source: The OECD Environmental Outlook Baseline Projections, Image Model, 2012, modified

Stabilization of Atmosphere at 450 ppm



Source: OECD 2012, Environmental Outlook Projections, IMAGE ENV Linkages Model

Mitigation szenarios

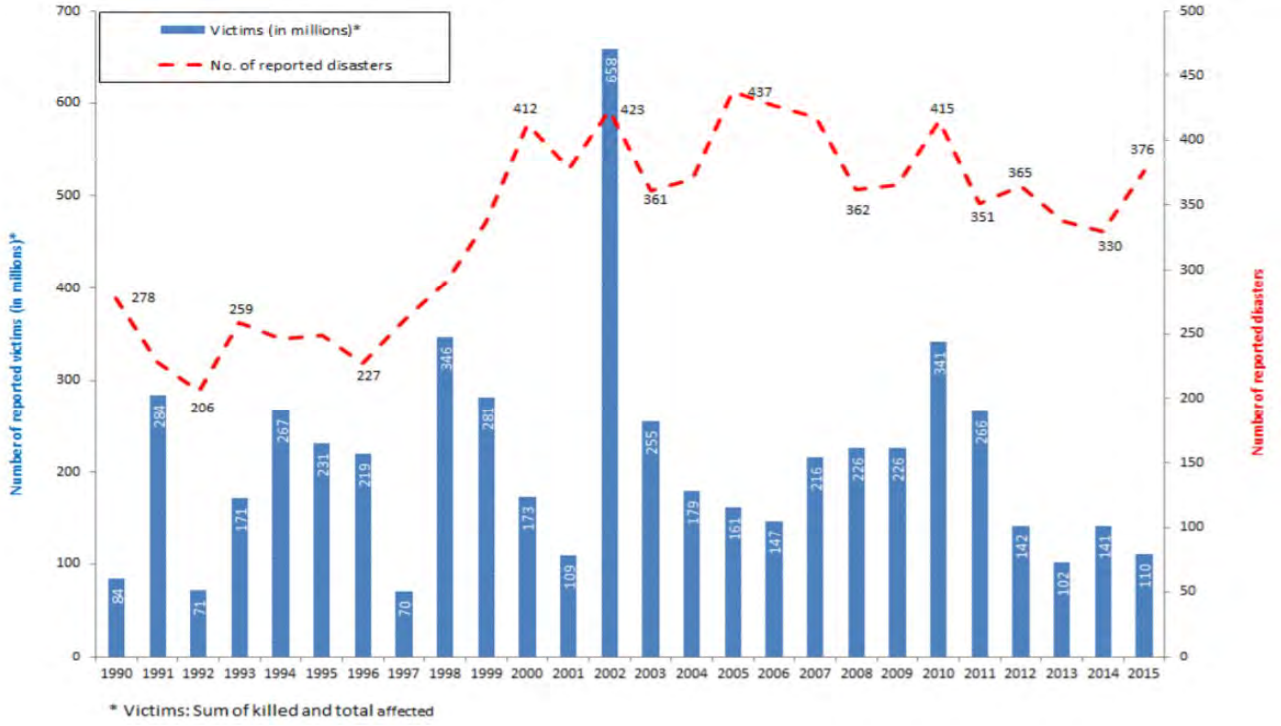
- All scenarios require immediate to fast actions
  - Tapping into less costly mitigation szenarios in 2012
  - To more demanding reduction efforts during this decade
- Smart Farm Efforts
  - Can principally contribute to reduction efforts
  - Smart farming is still innovative and not yet established for large scale food production
    - Exemption with some horticultural crops: e.g. paprika, cucumbers, tomatoes,
    - Investments into large scale live stock units were considered as most profitable during recent years

Stabilization Requirements

- Emissions must peak before 2020
  - Highly unlikely: after 2025 considered as possible
- Concentration 450 ppm in atmoshere
  - An overshoot is expected before a reduction is likely
- A significant carbon prize
  - Carbon emission price trading assumes a price of USD 350.- in 2050
  - In 2016 it was USD 7.- or 2% of target value
- Ambitious mitigation lowers the risk of catastrophic climate change
  - Disasters and damages and losses due to disasters will increase

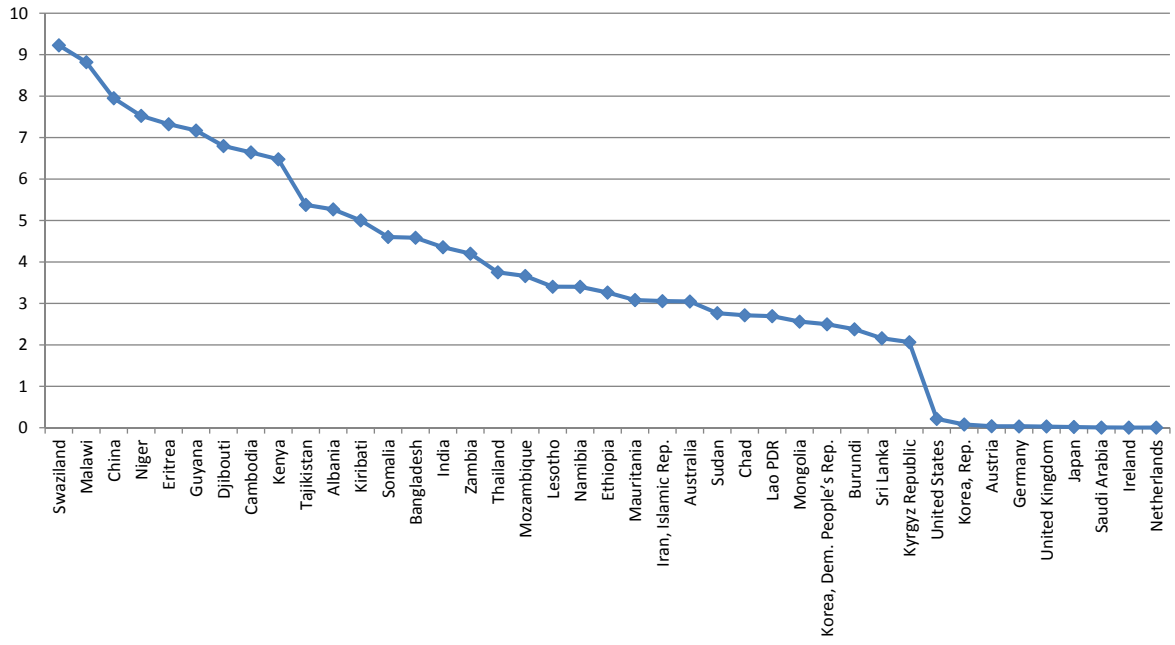
Source: OECD 2012, Environmental Outlook Projections

Global reported disasters and victims 1990 to 2015



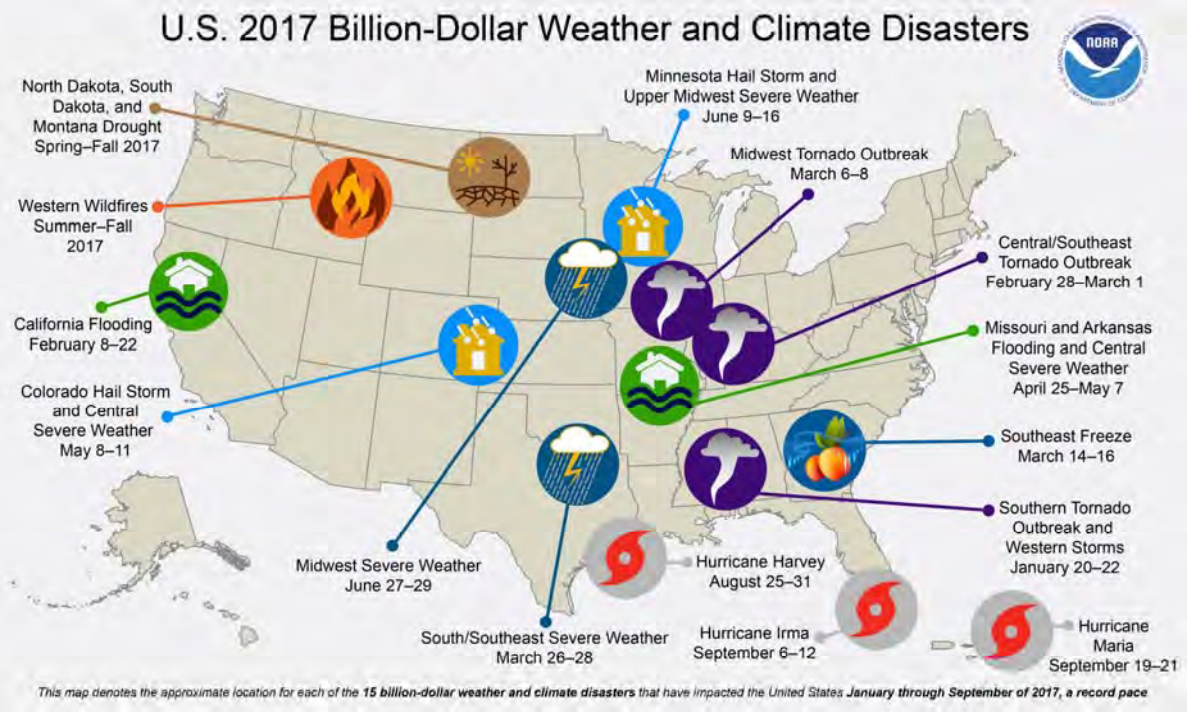
Sourcre: cred.be/sites/default/files/ADSR_2015.pdf

Average of population affected by climate (floods, droughts, extreme temperature) disasters 1990-2009



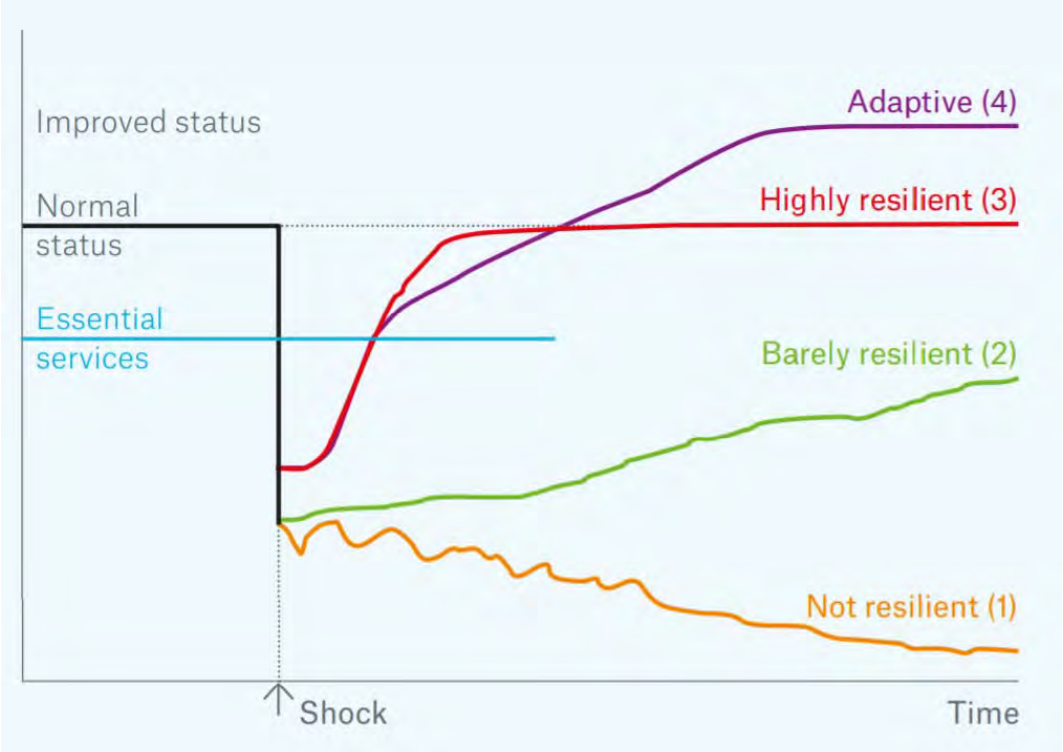
Source: World Bank EN.CLC.MDAT.ZS Droughts, floods, extreme temperatures (% of population, average 1990-2009)

Record Year 2017 in USA



Source https://www.ncdc.noaa.gov/billions/

Principal directions after natural disasters

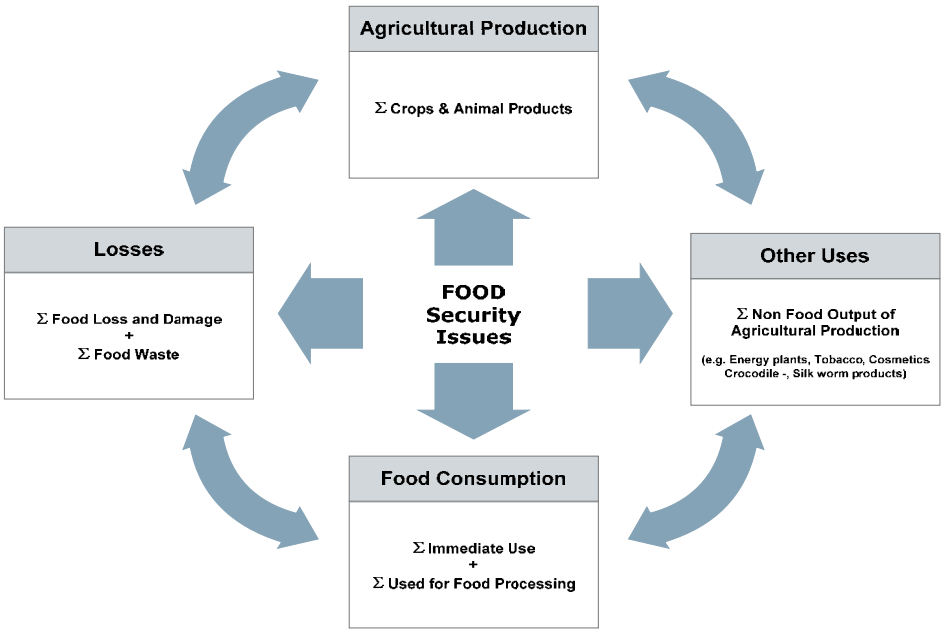


Source: Munich Re 2017

Part 3: Major challenges to Food Security

- Food security is complex
  - Prevailing conditions
    - Social, life style
    - Economic possibilities
      - Technological development
        - » Allows for improved food safety standards
  - Importance of agriculture
    - Degradation of agricultural land
    - Decrease in rural population
    - Increase of urban agriculture and food supply
  - More varied and sophisticated food processing
    - Ever more food variants are produced
  - Food distribution channels become larger
    - Ever more food is exported and imported

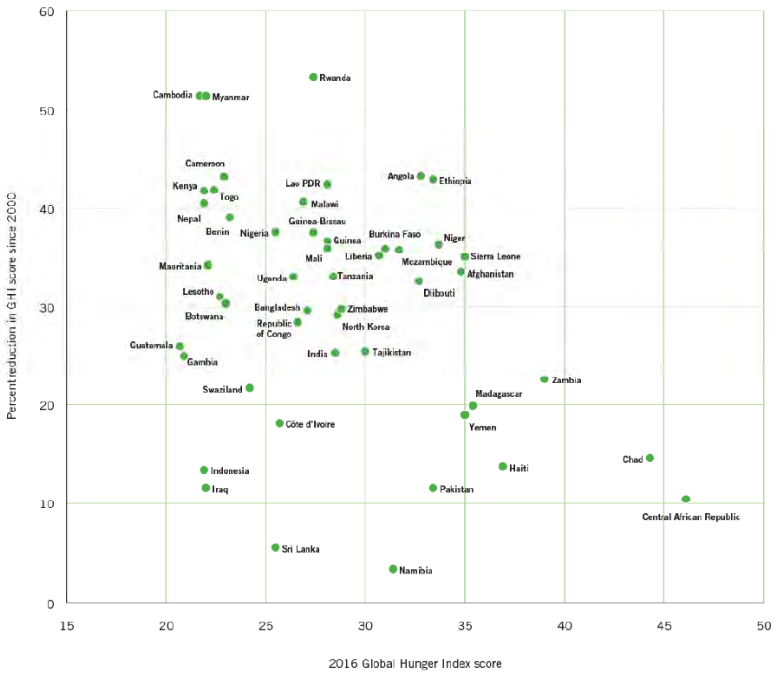
Food Security Issues



Source: 2017 – Breiling

Hunger – Global Hunger Index

- 10% of global population or 760 million suffer from occasional or permanent food shortage
- Primarily developing countries are endangered



http://ghi.ifpri.org/

Declining Land Resources – Decrease of Soil Quality

- Land resources are overexploited
- Natural capital is wasted
- 60% of all ecosystem services are degraded
- Since 1900, about 75% of genetic diverssity of agricultural crops has been lost
- Some 25% of land is highly degraded or undergoing high rates of degradation
- Land use change and degradation accounts for 20% of CO2 emissions

Source: 2014_UNCCD_Land_in_numbers_p2.pdf

Declining Water Resources

- Just 3% of earth water resources are freshwater
- Some 70% of used freshwater is used for agriculture
  - Many reservoirs like glaciers are shrinking and irrigation becomes much more difficult
- Ground water depletion is a serious problem
  - Depleting groundwater contributes to sea level rise with 0.8mm a year
  - Salinization of freshwater resources limits quantities and qualities
- Only 0.3% of food calories intake is produced in water
  - The production in land is still 300 times higher

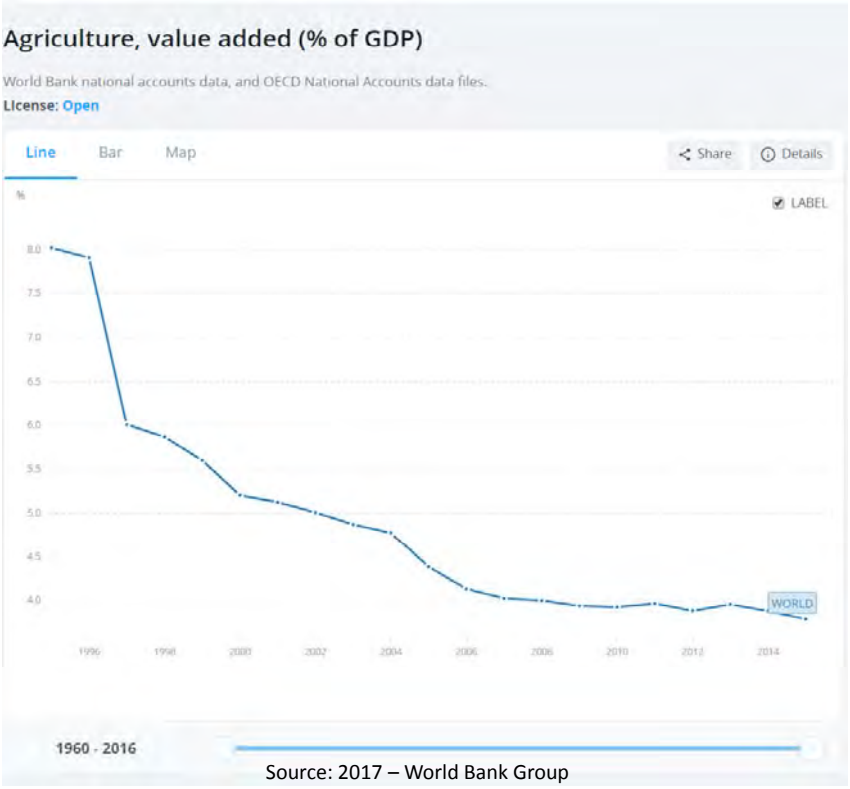
Source: 2014_UNCCD_Land_in_numbers_p2.pdf

Linkage Land, Conflict, Displacement

- 40% of all intrastate conflicts in the past 60 years are linked to natural resources.
- Over 70% of all countries in the world declare that climate change impacts – like land degradation and drought - are national security issues.
- In 2008, more than 60 food riots occurred worldwide in 30 different countries, 10 of which resulted in multiple deaths.
- Some 135 million people may be displaced by 2045 as a result of desertification.

Source: 2014_UNCCD_Land_in_numbers_p1.pdf

Value of Agriculture in GDP

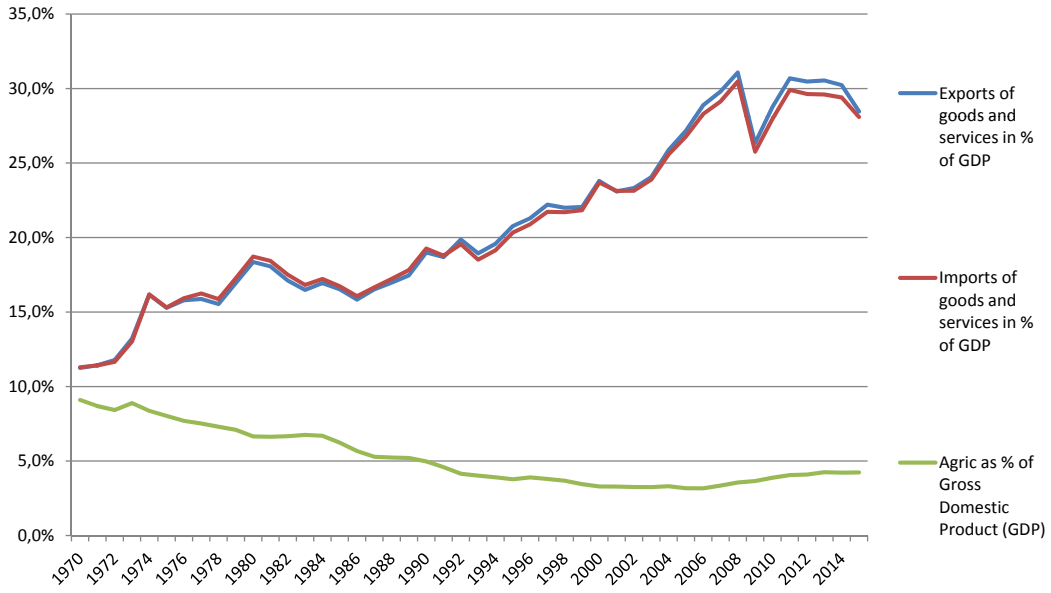


Source: 2017 – World Bank Group

GDP in Agriculture

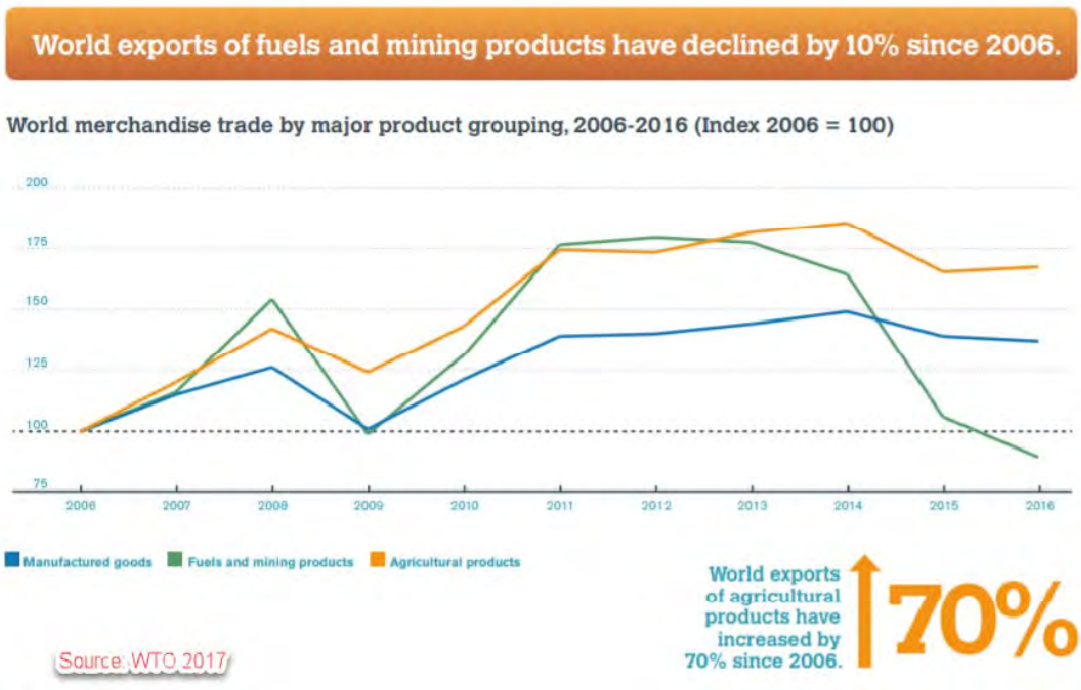
- With economic growth GDP in agriculture is shrinking
- Currently the value is under 4% and continues to shrink!
  - Large variations according to regions: Africa 15%, Asia 8%, Americas 1.8%, Au-Nz 2.7%, Europe 1.6%
  - High percentage in developing countries
    - Relates als to high degree of subsistance agriculture
  - Low percentage in industrialized countries
    - Large export nations can have a fairly low agriculture GDP

Global Development of Imports, Exports and Agricultural GDP 1970-2015



DATA SOURCE https://unstats.un.org/unsd/snaama/dnlList.asp

World exports from agricultural products increased by 70% since 2006



Agriculture gets more value

- During 2006 and 2016 highest value growth within agricultural production
  - Agriculture regains lost value
    - Relates to trade agreements of agricultural commodities
    - Higher quantities of grain imports to feed livestock
- Smart farming methods become more feasible
  - More money is available in agriculture
  - Technology improves
  - More farmers can afford smart farm technologies

Standardized Production by Controlled Processes

- Smart Farming covers a wide range of technologies
  - Different technologies can be linked and optimized
  - Current performance rates can be widely improved
- Innovations are on the way
  - Smart Farming is still in the initial phase and not yet widely applied
  - Prices of smart farm applications are likely to decrease considerably
- Linking new technologies
  - Different technologies can be linked to entirely new smart farming processes

Conclusion

- Smart Farming methods are in an initial stage and will grow in future
- Huge environmental problems related to agriculture and food production may remain unsolved
- Individual disaster risks can be reduced by implementing targeted smart farming methods